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EXACT EXPRESSIONS AND ACCURATE APPROXIMATIONS FOR THE DEPENDENCES OF RADIUS AND INDEX OF REFRACTION OF SOLUTIONS OF INORGANIC SOLUTES ON RELATIVE HUMIDITY

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ABSTRACT

Light scattering by aerosols plays an important role in Earth's radiative balance, and quantification of this phenomenon is important in understanding and accounting for anthropogenic influences on Earth's climate. Light scattering by an aerosol particle is determined by its radius and index of refraction, and for aerosol particles that are hygroscopic, both of these quantities vary with relative humidity RH. Here exact expressions are derived for the dependences of the radius ratio (relative to the volume-equivalent dry radius) and index of refraction on RH for aqueous solutions of single solutes. Both of these quantities depend on the apparent molal volume of the solute in solution and on the practical osmotic coefficient of the solution, which in turn depend on concentration and thus implicitly on RH. Simple but accurate approximations are also presented for the RH dependences of both radius ratio and index of refraction for several atmospherically important inorganic solutes over the entire range of RH values for which these substances can exist as solution drops. For all substances considered, the radius ratio is accurate to within a few percent, and the index of refraction to within ~0.02, over this range of RH. Such parameterizations will be useful in radiation transfer models and climate models.

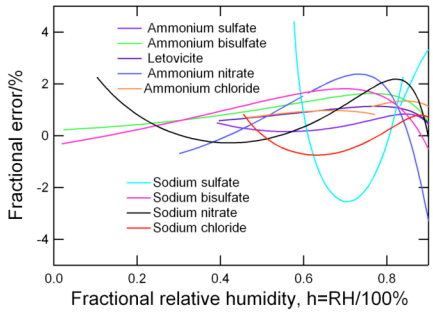

Figure caption: Fractional error in expression for radius ratio as a function of fractional relative humidity $h=RH/100\%$ for nine inorganic solutes of atmospheric importance.